countries devote around 6,000€ per capita annually, compared to others that only spent as little as 350€.
These increases, along with the global economic crisis, have stimulated the interest for more accurate information about the exact health care costs and on the way we spent our money. Health services research (HSR), a "multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviors affect access to health care, the quality and cost of health care, and ultimately, our health and well-being" is intended to guide the decisions of managers and policy makers about the design and implementation of health care programs.
Heath Technology Assessment (HTA), one component of HSR, addresses five central questions related to efficacy, effectiveness, efficiency, availability and distribution of health care and thus plays an essential role in modern health care by supporting evidence-based decision-making in policy and practice. Answers to the question of efficiency - or cost-effectiveness - are typically given by economic evaluations (EE). Full EEs involve the quantitative evaluation of both costs and outcomes, or consequences, of competing interventions. An appropriately performed EE is incremental, that is, it measures the extra cost incurred in order to obtain the incremental improvement in outcome. Understandably, the inputs used to perform such EEs have to be chosen with care if one wants to derive results that correctly support decision-making on resource allocation. Apart from the indispensible data on effectiveness, the accurate computation of the cost component is equally important.
The presentation will zoom in on the above aspects of HSR through examples from radiation oncology and evaluate why it is important to invest on this type of research.

SP-0374
How to incorporate cost calculation into our research?
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The methodology used to measure cost in economic evaluations in healthcare, as in clinical studies, is key to determine the health economic study's robustness. On-going literature review, investigating how costing is conducted in radiotherapy shows that one third of selected articles did not follow any conventional cost accounting methodology [Defourny 2015]. This demonstrates the absence of clear practices in reporting cost calculation [Graves 2002] and the lack of understanding the influence of a cost calculation method on final cost results [Doshi, 2006].
A feature of the healthcare sector is the coexistence of different types of accounting: NHS reimbursement's billing, hospital finance's invoices, insurances' clients' bills and so forth. These similarities tend to create confusion on how to implement costing exercises in a clinical study [Kaplan, 2014]. Cost accounting captures real economic cost not the 'financial accounts' [Mankiw, 2007]. The economic value of an expense, commonly known as the opportunity cost, is defined as the value of the benefit you could have realized by investing the same amount of money in taking the best alternative option. Economic theory measures item by capturing its opportunity cost in monetary terms.
Given the interrelated heterogeneous costs in the healthcare sector, health economics recommends selecting the relevant costs that matches the costing study perspective. Taking all other perspectives into account, the societal perspective is the most comprehensive approach because it also includes the productivity loss of the patient [Drummond 2005]. When authors want to inform decision makers about the real cost of an intervention, the global cost involved in the delivering of treatment, has to be computed, only then is the information relevant to explore whether this intervention is cost-efficient [Kaplan, 2014]. Conclusively, the relevant evaluation choice comes down to what the study wants to determine.
The method's choice influences the cost result [Mercier, 2014]. Authors have to decide on the appropriate costing method to use. The choice of sound methodologies will facilitate comparisons across studies.Cost accounting methods for cost calculation are categorized by an axis linking two distinct margins: top-down (activity-based costing, ABC) and bottom-up (micro costing). The top-down method uses total department expenses as first step to untangle the different resource's costs. The bottom-up approach records individual expenses and cumulates it per resource types. The advantages of the bottom-up approach were merged in a top-down framework in the time-driven activity-based costing (TDABC). ABC and micro-costing methods assume inherently full resources utilization, only if it can be established that the actual number of treatment courses delivered by an RT unit is using all the available resources, is the result of these cost accounting models robust. In contrast, TD ABC method does not start off with this premise. By incorporating the actual resource usage rate with the state of the art one, this cost method reveals areas for the improvement in the allocation of resources. Developing a study calculating the real cost of delivering an intervention will contribute to "solving the healthcare expenses crisis" [Kaplan 2014].
To conclude, costing methods have to be relevant, sound and transparent to be a useful tool to decision maker [Sullivan, 2011].

SP-0375
How to calculate cost-effectiveness?
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The field of radiotherapy is innovating rapidly. These innovations are often associated with better health, but also with higher costs. As healthcare budgets are scarce, we are increasingly asked to show that the effects of new radiotherapy techniques are worth the extra costs. In this presentation I will explain how to undertake such an analysis. This presentation provides an introduction to the principles and practice of economic evaluation. Topics include different types of economic evaluation, trial-based and model-based economic evaluation, use of quality-adjusted lifeyears and interpreting and presenting evidence. Throughout the presentation I will provide practical examples from the field of radiotherapy.

Poster Discussion: Dosimetry

PD-0378
Proton range assessment using prompt gamma monitoring of realistic pencil beam scanning treatments
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Purpose/Objective: Range uncertainties in proton therapy can be reduced using in-vivo range verification based on prompt gamma (PG) imaging. In pencil beam scanning, PG emission can be measured for all pencil beams of the treatment and compared to the treatment planning in order to detect potential range discrepancies. This study proposes a strategy to analyze the large amount of PG profiles acquired during treatment using a priori simulations.
Materials and Methods: Pencil beam scanning treatments were planned on an anthropomorphic phantom. Brain, nasal cavity and lung cases were included in the study. The treatments were delivered to the anthropomorphic phantom at the Proton Therapy Center in Prague, and PG monitoring was performed using a knife-edge slit gamma camera. Both single fraction (2 Gy) and full treatment at once (60 Gy) were delivered and measured. A dedicated analytical PG simulator was used to compute the expected PG profiles for all pencil beams of the treatment in the planning configuration. Several scenarios, corresponding to several possible sources of range discrepancy (i.e. setup errors, CT calibration errors and energy errors), were simulated as well. The corresponding range shifts were computed based on CSDA approximation in order to estimate the range sensitivity. Moreover, the range shifts were estimated from the simulated profiles using a range retrieval method. The difference between CSDA-based shifts and shifts estimated from the simulated PG profiles defined the expected systematic error in range retrieval for each pencil beam. The actual range was then estimated based on the comparison of measured and simulated profiles. The range shifts were also retrieved from the comparison of 2 Gy and 60 Gy acquisitions in order to evaluate an occurrence of the random errors. In order to improve range assessment, a selection of the most reliable pencil beams was done based on weight and expected systematic errors.
Results: Realistic treatments were successfully delivered to an anthropomorphic phantom and monitored using the PG camera. Using all pencil beams, the average systematic range shift extracted from the comparison of the 60 Gy acquisition with the simulation were of 4.1, 5.8 and -4.0 mm for brain, nasal cavity and lung, respectively. The average random error was of 2.4, 4.5 and 2.2 mm. When selecting the pencil beams whose weight was higher than 0.3 MUs and whose systematic error was smaller than 1 mm, the systematic range shift was 4.1, 6.8 and -3.2, and the random errors went down to 1.6, 1.9 and 2.2 mm.

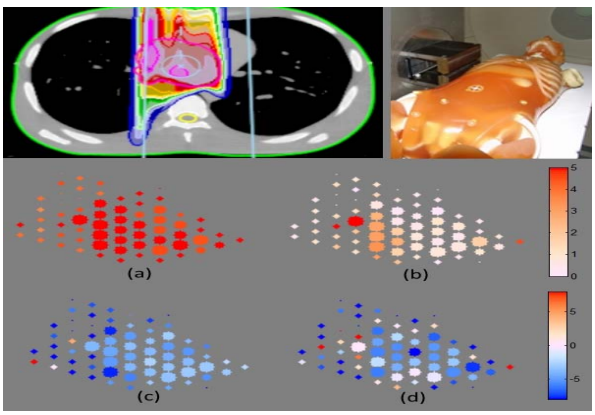

Figure: Treatment plan (top-left), experimental setup (top-right), and range analysis on first energy layer (bottom): (a) range sensitivity to energy variations of +/- 3 MeV on first layer; (b) systematic error on range retrieval for energy variations; (c) range shifts from 60 Gy acquisition; (d) range shifts from 2 Gy acquisition. The size of the spots is proportional to their weight.
Conclusions: The first prompt gamma-based range monitoring of realistic proton pencil beam scanning treatments on an anthropomorphic phantom were successfully conducted and a strategy to extract range discrepancies was proposed.

PD-0379

Reducing the dose-rate dependence of a new radiochromic silicone based 3D dosimeter

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Purpose/Objective: Radiochromic 3D dosimetry has great potential for verification of complex treatment techniques such as adaptive radiotherapy and proton therapy. However, the response to irradiation is often dependent on dose-rate, which can limit their use in clinical environments. Recently, we have developed a radiochromic silicone-based 3D dosimeter, where the first generation of the dosimeter had an issue with dose-rate dependency. However, by changing the chemical composition of the dosimeter, we have in this study reduced the dose-rate dependence to a clinically acceptable level.
Materials and Methods: The silicone-based dosimeters were produced by mixing leuco-malachite green (LMG) dye as the active component, 1 % (w/w) chloroform as the initiator and a silicone elastomer as the host matrix. All dosimeters were left to cure for two days at room temperature. Thereafter they were irradiated with a linac to doses in the range 0-30 Gy, in a 10 cm square field and with a beam quality of 6 MV. During irradiation they were placed at SSD 94.5 cm between two 5 cm slabs of solid water. Experiments were performed at dose-rates of 200 MU/min and 600 MU/min for a series of dosimeters with different LMG concentrations. The dosimeters were then read-out using a spectrophotometer at 627 nm before and after irradiation to obtain the change in optical density (Δ OD) caused by the irradiation. Δ OD was plotted as a function of dose and fitted to a linear expression with the slope giving the dose response. The dose-rate dependence was then expressed as the percentage difference between the dose responses of the two dose-rate measurements, relative to the 200 MU/min measurement.
Results: The dose-rate dependence was greatly reduced with increasing dye concentration (Figure). Below 0.05 % (w/w) LMG it was observed to be around 17 %, while it was eliminated in dosimeters containing 0.25 % (w/w) LMG. For higher dye concentrations the dose-rate dependence was reversed. Similar observations were made for dosimeters with 5 % (w/w) chloroform.
The stability of the dosimeters was found to decrease linearly with increasing LMG concentration, with a 50 % decrease within a day for a concentration of 0.2 % (w/w) LMG. In addition, at the highest concentrations precipitation was observed within days to weeks after production.